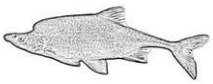
LITTLE COLORADO RIVER FISH MONITORING
2007 ANNUAL REPORT



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INTRODUCTION

In 1987, the Arizona Game and Fish Department (AGFD) began monitoring of fishes in the Little Colorado River (LCR) to assess population trends and status of the endangered humpback chub (*Gila cypha* HBC; Robinson and Clarkson 1992). Annual standardized hoop net sampling is conducted for 20 – 30 days each spring to capture humpback chub during the spring spawning period (Table 1). This program was discontinued in 2000 but then reinstated in 2002 at the advice of the Grand Canyon Monitoring and Research Center Protocol Evaluation Panel (Anders *et al*. 2001). Catch-per-unit-effort (CPUE) indices derived from this monitoring program are useful as independent validation for mark-recapture population models of humpback chub developed by Coggins *et al*. (2006). With the exception of 2000-2001, the lower 1200 meter sampling represents one of the most consistent, long-term sampling methods for Grand Canyon fishes.

STUDY SITE

The study site is the lower LCR, 1,200 m upstream from its confluence with the Colorado River. The LCR in the study area is a deeply entrenched channel located in a vertical-walled canyon that, in places, narrows to less than 50 m. The LCR channel contains runs, riffles, deep pools and small rapids. Substrates are primarily silt and sand with scattered large boulders and travertine dams. The LCR is the primary spawning site for the endangered HBC in Grand Canyon and is the only known HBC aggregate in the Colorado River Ecosystem from which fish are known to recruit into the adult population (Valdez and Ryel 1995; Coggins and Walters 2001). Other native fishes, bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and speckled dace (*Rhinichthys osculus*) spawn in the LCR (Robinson *et al*. 1998) as do nonnative species including channel catfish (*Ictalurus punctatus*), fathead minnow (*Pimephales promelas*), red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*) and black bullhead (*Ameiurus melas*).

METHODS

We fished thirteen standardized AGFD hoop nets continuously from April 14 through May 7, 2007, checking nets once daily. Hoop nets measured 5 m long and 1 m diameter with 6.3 mm mesh, 7 hoops and two throats. Nets were set at 100, 119, 137, 165, 420, 480, 500, 577, 675, 1045, 1110, 1160, and 1195 m upstream from the confluence. Net locations were set as

close as possible to those used in previous sampling efforts (Brouder and Hoffnagle 1998). Catch-per-unit-effort was calculated as number of fish captured per hour.

All fish captured were handled following protocols in Ward (2002). All fish collected were identified to species and measured for total length (TL; nearest mm). Fork length was also measured for humpback chub, flannelmouth sucker, and bluehead sucker. Weights were not measured in an effort to reduce handling time and because high winds common during the study period do not allow accurate weight measurements. Analysis of previous weight data from this monitoring program also indicates these weights are not useful as an index of fish condition because sexual condition and tapeworm loads can confound weight data. Native fish were sexed when possible based on external sexual characteristics or manual expulsion of gametes and sexual condition (not ripe, ripe) was recorded. Examination of sexual characteristics (none, color, tuberculate) was also noted. Number and type of external parasites were recorded. Native fishes ≥ 150 mm TL were scanned for the presence of a Passive Integrated Transponder (PIT) tag with both a 134.2 kHz tag reader and an 400 kHz tag reader to verify that no tags were missed. If a tag was not found and the fish was ≥ 150 mm TL, a 134.2 kHz PIT tag was inserted into the abdominal cavity. Also, if captured native fish ≥ 150 mm TL possessed an old 400 kHz PIT tag, they were given a new 134.2 kHz PIT tag. Tag presence or absence and PIT tag number (old and new) were recorded. Fish were also checked for fin clips or elastomer dye (marks used in previous years to identify tag loss or fish translocated above Chute Falls; Stone and Sponholtz 2003). PIT tag information was downloaded electronically and checked for errors.

RESULTS

A total of 2,920 fish representing 10 species were captured in the LCR during standardized monitoring in 2007. Native species dominated the catch and comprised 98 % of total fish caught (Table 3). Speckled dace (SPD), humpback chub (HBC), bluehead sucker (BHS), and flannelmouth sucker (FMS) were the predominant species caught (Tables 3 & 5). Catch rates of native fishes were higher than in 2006 and have comprised over 90 % of the total catch since 2002, with the exception of 2006 (Figure 6). Catch rates of bluehead suckers in 2007 continue to be high and represent 10% of the overall catch (Table 3 & Figure 9).

The LCR was at or near base flow during the entire 2007 sampling period (Figure 4) with relatively low turbidity during the sampling period (Figure 5). In general, turbidity during the

entire sampling period was below 20 NTU (Figure 5). Water temperature ranged from 14 to 25 ºC during the sampling period (Figure 7).

Native species

Humpback chub

A total of 266 humpback chub were collected in standardized hoop net sets during the 2007 monitoring period. Humpback chub captured in 2007 had a mean TL of 191 mm and ranged in size from 45 mm to 475 mm.

We examined 169 humpback chub ≥ 150 mm TL for presence of a PIT tag and 88 (52 %) were PIT tag recaptures (Table 4). Only twenty-one humpback chub < 100 mm TL were captured. No ripe HBC were found in 2007. There were no humpback chub examined that were infected with *Lernaea* during 2007 sampling as opposed to 68 fish with *Lernaea* in 2006 (Figure 12). Of the 95 new tags that were inserted, 54 PIT tags were put into fish under 200 mm TL indicating that over half of the HBC that were tagged were younger fish. Twenty-nine of the 95 HBC were from 200-300 mm TL and 11 new tags were inserted into ≥ 300 mm TL humpback chub.

Flannelmouth sucker

Flannelmouth sucker captured in 2007 had a mean TL of 243 mm and ranged in size from 32 mm to 575 mm. Flannelmouth sucker were the second most abundant native species captured (644; 22%) in 2007 (Table 3). A total of 465 flannelmouth sucker over 150 mm TL were caught and 117 (25 %) were recaptures (Table 4). Flannelmouth sucker CPUE was the highest observed since the monitoring project began in 1987 (Figure 9). Flannelmouth sucker CPUE has been highly variable during the last 4 years but still indicates an increasing overall trend since 2002 (Figure 9).

Bluehead sucker

Bluehead sucker captured in 2007 had a mean TL of 201 mm and ranged in size from 50 to 340 mm TL. The mean TL of 201 mm is significantly larger than in 2006 (mean of 139 mm TL). A small cohort of age-0 bluehead sucker was detected in 2007 indicating spawning of bluehead sucker may have occurred relatively early in 2007 and some age-0 bluehead sucker were large enough to be captured during the sampling period (Table 6). A total of 255 bluehead sucker were scanned for presence of a PIT tag, with 16 recaps (6.2 %) (Table 4). The CPUE of bluehead sucker continues to be the highest observed since monitoring began in 1987 (Figure 9).

Speckled dace

Speckled dace were the most abundant species observed in 2007 with 1,644 individuals captured (Table 3). The CPUE of speckled dace is highly variable among years but recent data suggests an increasing trend since 2002 (Figure 9).

Nonnative species

Nonnative species made up 2 % of the total catch in 2007 with fathead minnow (FHM) being the most abundant nonnative species caught (27%; Table 3). This is a significant decrease in FHM numbers since 2006 where 1,286 fathead minnows were captured (Table 5). The CPUE of common carp (CRP) remains relatively high and is similar to 2003 (Figure 10). The CPUE of black bullheads (BBH) was the second highest recorded since monitoring began in 1987, with an increasing trend since 2002. Two adult BBH were captured and measured 555 mm and 490 mm TL (Figure 10 and Table 6).

DISCUSSION

Native species

Catch rates of native fishes in 2007 were generally lower in 2007 than in 2006, with the exception of FMS, even though the LCR was at baseflow conditions during the sampling period with low turbidity. Recent investigations of the effects of turbidity on hoop net catch rates have revealed that turbidities < 180 NTU increase catch rates significantly (Stone 2004). Fish may use the nets as cover in clear water. One factor that may have contributed to the lower catch rates for 2007 was a minor flood event prior to the sampling period, which may have moved fishes out of the LCR into the mainstem Colorado River. In general, catch rates of native fishes show an overall increasing trend since 2002.

Humpback chub

The mean CPUE of humpback chub ≥ 150 mm TL shows severe declines from 1987 to 1994 and has remained relatively stable since 1994. It is likely that the pre-1987 population of humpback chub represented individuals that were born prior to or during the time in which Lake Powell was filling when mainstem Colorado River water temperatures were warmer and the mainstem Colorado River was more suitable humpback chub habitat. Since 1994, the number of humpback chub has been relatively stable at lower levels. This may indicate that the present humpback chub population represents the carrying capacity of the Little Colorado River alone

and the higher pre-1987 chub population represented the combined carrying capacity of the mainstem Colorado River and the Little Colorado River. The non-native fish removal efforts near the confluence of the Little Colorado River that ended in the fall of 2006 were designed as an experiment to determine if the mainstem Colorado River becomes more suitable humpback chub habitat. If humpback chub numbers do not increase as a result of these efforts, it may be that the mainstem Colorado River is still unsuitable humpback chub habitat possibly due to cold water temperatures, even after predators were removed. Warmer mainstem water temperatures due to current drought conditions and low water levels in Lake Powell will make interpretation of recent increases in CPUE of native fish even harder to interpret.

The catch rate of humpback chub 151-199 mm TL has been slightly higher in 4 of the last 5 years compared to those observed between 1994 and 2002. Although large numbers of age 0 and age 1 humpback chub (< 100 mm TL) were caught in 2004 and 2006, length frequency histograms do not indicate these young humpback chub are transitioning into larger adult fish. Length frequency histograms in 2007 showed few age 0 and age 1 humpback chub were captured, suggesting these fish were likely upstream of our sampling effort, or may have been displaced into the mainstem Colorado River due to the flushing flows prior to our sampling effort.

Flannelmouth sucker

In 2007, mean CPUE of flannelmouth sucker was the highest observed since monitoring began in 1987. Over the last three years, flannelmouth sucker catch rate has shown an increasing trend, with an overall increase in relative abundance since 2002. Catch rates of flannelmouth sucker collected in the Little Colorado River and in the mainstem Colorado River within Grand Canyon between 1991 and 2000 suggested that the population was stable with few strong year classes and was dominated by age 0 fish (< 150 mm TL) and adults (> 400 mm TL). Recent monitoring in the Little Colorado River (2002-2007) as well as electrofishing in the mainstem shows evidence of increased abundance of sub-adult flannelmouth sucker. This trend is most evident in mainstem electrofishing data between 233 km and 346 km downstream of Glen Canyon Dam (Scott Rogers AGFD, *personal communication*). The observed trend corresponds temporally and spatially to an increased number of days with water temperature greater than 15°C. It is likely that increased river temperatures resulting from lower Lake Powell water levels

and stable summer discharge in 2000 from Glen Canyon Dam are partially responsible for the increased recruitment of flannelmouth suckers within the Little Colorado River.

Bluehead sucker

Catch of bluehead sucker ≥ 150 mm TL increased from 2006 levels and still shows a consistently increasing trend since 2002. The catch rates of bluehead sucker in 2005 and 2007 are the highest recorded since monitoring began in 1987. At least two distinct cohorts of bluehead sucker were observed in 2007. Warmer mainstem water temperatures caused by drought conditions and lowered water levels in Lake Powell (Susan Hueftle, USGS unpublished data) may have led to increased survival of suckers. The removal of predatory nonnative species around the confluence of the Little Colorado River may also be partly responsible for the increased catch of suckers within the Little Colorado River. Although separating the effects of warmer water and fewer predators may take several more years of investigation. The overall effect appears to have been beneficial to sucker populations. Sixteen bluehead suckers were recaptured in 2007, twice as many recaptures as in 2006.

Speckled dace

Catches of speckled dace are highly variable among years, but do show an increasing trend within the last 4 years, with the exception of 2005. Warmer mainstem water temperatures and fewer introduced predators are expected to benefit speckled dace populations, as well as humpback chub and sucker populations.

Nonnative species

The percentage of nonnative fishes in the Little Colorado River continues to remain at low levels. There is some indication that the number of fathead minnow has increased since 1994 although high variation in catch rate between years makes trends difficult to assess. The catch rate of fathead minnow in 2007 was significantly lower than in 2006. The decrease in fathead minnow catch rate may be a result of spring run-off disadvantaging small-bodied nonnatives or due to an extremely high concentration of these fish from 2006 forcing them into the mainstem Colorado River, due to density-dependent constraints in the LCR. Catch rate of red shiner also appears to have increased since 2002, with the exception of 2005 and 2007. Black bullhead have shown higher variability in catch rates since 2002. Relative abundance of

black bullhead in 2007 was the second highest since monitoring began in 1987. The previously mentioned large adult black bullheads, identified by counting the number of anal rays and the absence of a forked tail, were significantly larger than any BBH previously captured in the LCR. Due to logistical and time constraints these specimens were not preserved. All unusual specimens will be preserved in future monitoring activities. Catch of channel catfish is also highly variable creating very large confidence intervals surrounding the mean. This makes it difficult to assess trends for channel catfish although there are indications of a stabilizing trend since 2002. No trends are evident in catch rate of common carp, although large numbers of adult carp are visually observed throughout the LCR. Adult carp are not very susceptible to capture in hoop nets within the Little Colorado River so hoop net catch trends are not likely to be a good index of the adult carp population.

The pattern of nonnative fish abundance in the Little Colorado River is not typical of most southwestern streams. Typically, once small-bodied, introduced species such as fathead minnow or red shiner appear they gradually increase in abundance over time until they numerically dominate a fish assemblage (Marsh and Pacey 2005). The extreme flood regime and high turbidity of the Little Colorado River during the spring and late summer may prevent these nonnative species that are adapted for more stable systems from becoming established (Minckley and Meffe 1987, Ward et al. 2003). If the mainstem Colorado River continues to warm due to drought conditions, fathead minnow and red shiner may be able to become established in the mainstem and invade the Little Colorado River between flood events much more quickly. Catch rates of nonnative predatory fishes appears to be increasing over the last two years, especially black bullhead and juvenile common carp. The increase in these species may be attributed to downstream immigration from unregulated stock ponds within the LCR watershed (Stone et al. 2007), or seasonal food availability.

Strengths of lower 1200 meter monitoring

The lower 1200 meter hoopnet monitoring represents one of the longest ongoing trend indexes for Grand Canyon fishes. The real strength of this data set is the length of time over which the data has been collected in a consistent manner. Catch-per-unit-effort indices derived from the lower 1200 meter monitoring show dramatic declines in relative abundance of adult humpback chub and validate mark-recapture population estimates. This index of catch rate is also valuable as an independent method to confirm output of age-structured mark/recapture

(ASMR) open population models. The lower 1200 meter standardized hoop net monitoring should be assessed by the upcoming protocol evaluation panel as a means of comparing catch rate data with population estimates from the Fish and Wildlife Service and validating age structured mark-recapture stock assessment models produced by the Grand Canyon Monitoring and Research Center.

Additional projects done in conjunction with lower 1200 meter monitoring

Several small studies were undertaken in 2007 in conjunction with the lower 1200 meter fish monitoring to answer specific questions related to native fishes. A short summary of each of these projects follows along with recommendations based on the results of those studies.

Remote detection of PIT tags

Recent technological advances and 134.2 kHz PIT tags have allowed new possibilities for remote detection of fish, which may help address questions of fish movement and population closure within the Little Colorado River. We evaluated the potential of remotely detecting PIT tags in fishes using continuous underwater PIT tag scanners (CUPS) to remotely detect tags in moving fish without handling them. This is the forth year of experimentation using this new technology. Two 11-inch diameter antennas were fastened in either the final hoop of a modified Fyke net (1/4 inch mesh, 1 m basket, 6 hoops and 3, 15 m leads) or in the final hoop of a large mesh hoop net (1 inch mesh, 6 hoops). The CUPS antennas were downloaded daily and fished between 21-24 nights in two separate locations near Boulders Camp. The remote antennas detected a total of 83 unique tags, one of which was an old 400 Khz tag. For comparison, the total number of unique PIT tags recaptured from the thirteen standard monitoring nets was 838. Nine fish were caught in both the standardized lower 1200 monitoring nets and in the CUPS antennas. Thirteen fish were detected in both CUPS.

The location of the two CUPS were downstream of Boulders camp. One CUPS was located approximately 20 meters downstream of Boulders camp on river left and the second CUPS was about .5 Km downstream of camp on river left. The CUPS sampling sites have been consistently placed over the last two years. Both CUPS locations are a considerable distance upstream of net # 13, which is the most upstream hoopnet set.

The use of larger batteries and additional solar panels this year helped the units to operate continuously. This type of non-intrusive sampling with a remote antenna could be used in conjunction with a temporary weir to answer questions about population closure, spawning and movement patterns of humpback chub in the Little Colorado River. Also, with further advancement of the remote detection technology several array types and combinations are becoming available (Flat-plate antenna, Crump weir (Biomark)). We believe it is time to move past the experimental phase of this project and implement remote detection of PIT tags in the Little Colorado River on a larger scale.

Removal and quantification of Asian tapeworm

Thirty humpback chub were captured in May 2007 in conjunction with lower 1200 meter monitoring efforts and treated with Praziquantel to remove Asian tapeworm (*Bothriocephalus acheilognathi*) according to protocols established in the laboratory (Ward 2006). No mortality or abnormal behavior was noted in any of the humpback chub that were treated. Tapeworm infestation in humpback chub from the Little Colorado River was again highly variable with a low infestation in all size classes of fish that were sampled. Tapeworm infestation in 2007 (33 %) was lower than in 2006 (80 %) and similar to infestation rates in 2005 (39 %). The reason for the differences in infestation from year to year are unknown, but are likely linked to hydrologic conditions with baseflow being more conducive to tapeworm proliferation. This sampling methodology appears to be a good, non-lethal method for quantifying tapeworm loads in endangered fishes, although tapeworm loads appear to vary widely spatially. The localized nature of the lower 1200 meter monitoring gives a limited view of tapeworm dynamics in the river as a whole and gives baseline information only. More extensive sampling is likely to be needed to adequately assess the impacts of warmer mainstem water temperatures on Asian tapeworm populations, as well as impacts of Asian tapeworm infestation on humpback chub.

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TABLES

Table 1. Little Colorado River hoop netting effort by year, 1987 – 2007.
This is only HN gear types fished during April and May in the Lower 1200 meters of the Little Colorado River.

Year	Effort (Hours)	Days
1987	1428	21
1988	3668	26
1989	4920	25
1990	4479	27
1991	7773	58
1992	6038	55
1993	9116	31

Year	Effort (Hours)	Days
1994	9987	32
1995	9449	30
1996	9175	30
1997	9076	31
1998	7060	21
1999	9373	25
2000	0.00	0

Year	Effort (Hours)	Days
2001	0.00	0
2002	3138	30
2003	3415	25
2004	7190	23
2005	6333	26
2006	7417	24
2007	6695	21

Table 2. Trip dates and number of net sets 1987 - 2007.

Lower 1200 meter LCR trips					Average duration of set	
Year	Start	End	Trip ID	Days	in hours	# of net sets per year [a]
1987	9-May	30-May	LC19870509	21	11.52	124
1988	3-May	29-May	LC19880503	26	11.15	329
1989	3-May	28-May	LC19890503	25	24.00	205
1990	17-Apr	14-May	LC19900417	27	23.70	189
1991	3-May	30-Jun	LC19910503	58	14.56	534
1992	5-May	28-May	LC19920505	23	18.93	319
1993	30-Apr	31-May	LC19930430	31	12.25	744
1994	19-Apr	21-May	LC19940419	32	12.27	814
1995	20-Apr	20-May	LC19950420	30	12.01	787
1996	18-Apr	18-May	LC19960418	30	12.25	750
1997	13-Apr	14-May	LC19970413	31	12.05	753
1998	5-Apr	26-Apr	LC19980405	21	16.38	431
1999	7-Apr	1-May	*GC19990406	24	18.86	497
2002	19-Apr	19-May	LC20020419	30	24.14	130
2003	11-Apr	9-May	LC20030411	28	24.75	138
2004	9-Apr	3-May	LC20040409	24	24.05	299
2005	8-Apr	6-May	LC20050408	26	23.99	264
2006	7-Apr	5-May	LC20060407	24	24.44	312
2007	15-Apr	7-May	LC20070414	21	25.75	260

[a] This number represents all hoop nets set within the lower 1200 meters of the LCR during the months of April and May but does not include Fyke nets or D hoop nets.
* 1999 has a GC extension because it was submitted with USFWS downstream data.
From 1993 to 1997 nets were often checked twice daily which led to a higher number of net sets.

Table 3. Catch by species, lower 1200 m hoop net monitoring, Little Colorado River, April 15 - May 7, 2007.

Species	Number	%
Bluehead sucker (BHS)	304	10.39
Flannelmouth sucker (FMS)	644	22.05
Humpback chub (HBC)	266	9.10
Speckled dace (SPD)	1644	56.3
Total Native	**2858**	**97.87**
Black bullhead (BBH)	9	.30
Channel catfish (CCF)	3	.10
Common carp (CRP)	13	.44
Fathead minnow (FHM)	17	.58
Plains killifish (PKF)	12	.41
Rainbow trout (RBT)	0	0.00
Red shiner (RSH)	8	.27
Total Non-native	**62**	**2.12**
Total	**2920**	**100**

Table 4. Number of fishes scanned, tagged, and recaptured by species during LCR lower 1200 meter hoop net monitoring, 2007.

Species	<150 mm TL	> 150 mm TL	New tags inserted	Recaps	Total Catch
BBH	1	8			9
BHS	49	255	237	16	304
CCF	1	2			3
CRP	8	5			13
FHM	17				17
FMS	179	465	348	117	644
HBC	97	169	95	88	266
PKF	12				12
RBT					0
RSH	8				8
SPD	1644				1644

* Total Effort = 6695 hours of soak time

Table 5. Total catch of species by year, LCR standardized hoop net monitoring 1987-2007.

Species	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2002	2003	2004	2005	2006	2007
BBH									1		1	1			3	5	4	12	9
BHS	39	65	72	25	106	19	44	64	32	413	45	27	61	122	93	154	347	395	304
CCF	5	8	41	2	4	8		5	1	1	12	5	10	1	3	7	3	13	3
CRP	2	1							1	8	60		5		7	7	1	19	13
FHM	1	12	17	10	3	1	1	265	19	237	726	52	14	46	42	91		1286	17
FMS	81	91	28	30	106	25	50	88	65	237	97	6	21	79	256	357	192	483	644
GSH	1																		
HBC	396	596	548	418	316	199	431	657	243	359	123	132	156	130	157	743	344	587	266
PKF											97	1		1		52		9	12
RBT			1		1		2		1	8	1	4	6	3		5	1	1	
RSH			2							14	74	8	70	3	13	65		44	8
SPD	132	192	204	90	1003	110	455	1022	488	741	417	106	187	115	116	1918	445	3173	1644
SUC				3			1			2									

Table 6. Length frequency distribution of fish collected during LCR standardized hoop net monitoring, April 15 – May 7, 2007.

Length	Species										
	BBH	BHS	CCF	CRP	FHM	FMS	HBC	PKF	RBT	RSH	SPD
20 - 29											
30 - 39						1					1
40 - 49					1		2	2			21
50 - 59		18			7	2		9		5	188
60 - 69		17			6	8		1		3	549
70 - 79		6			3	13	8				431
80 - 89		5				18	2				257
90 - 99		1				18	9				108
100 - 109			1	1		24	27				49
110 - 119				1		23	17				5
120 - 129				1		15	12				2
130 - 139		1		1		30	10				
140 - 149	1	1		4		27	9				
150 - 159	1	1		2		22	16				
160 - 169	1					17	21				
170 - 179	1	5		1		23	14				
180 - 189	1	21				21	22				
190 - 199	1	26				15	9				
200 - 209		31				11	9				
210 - 219	1	37				16	10				
220 - 229		30				5	6				
230 - 239		18				7	7				
240 - 249		23		1		16	5				
250 - 259		17				12	4				
260 - 269		18	1			15	4				
270 - 279		9				11	3				
280 - 289		7				15					
290 - 299		7				16	5				
300 - 309		2				30	1				
310 - 319		2		1		23					
320 - 329						29	1				
330 - 339						18	1				
340 - 349		1	1			16					
350 - 359						16	1				
360 - 369						21	1				
370 - 379						13	2				
380 - 389						8	4				
390 - 399						11	6				
400 - 409						7	6				
410 - 419						11	6				
420 - 429						11	3				
430 - 439						10	1				
440 - 449						4					
450 - 459						1					
460 - 469						2					
470 - 479						2	1				
480 - 489						2					
490 - 499	1					3					
500 - 509						2					
510 - 519											
520 - 529											
530 - 539						2					
540 - 549											
550 - 559	1										
560 - 569											
570 - 579				1							

FIGURES

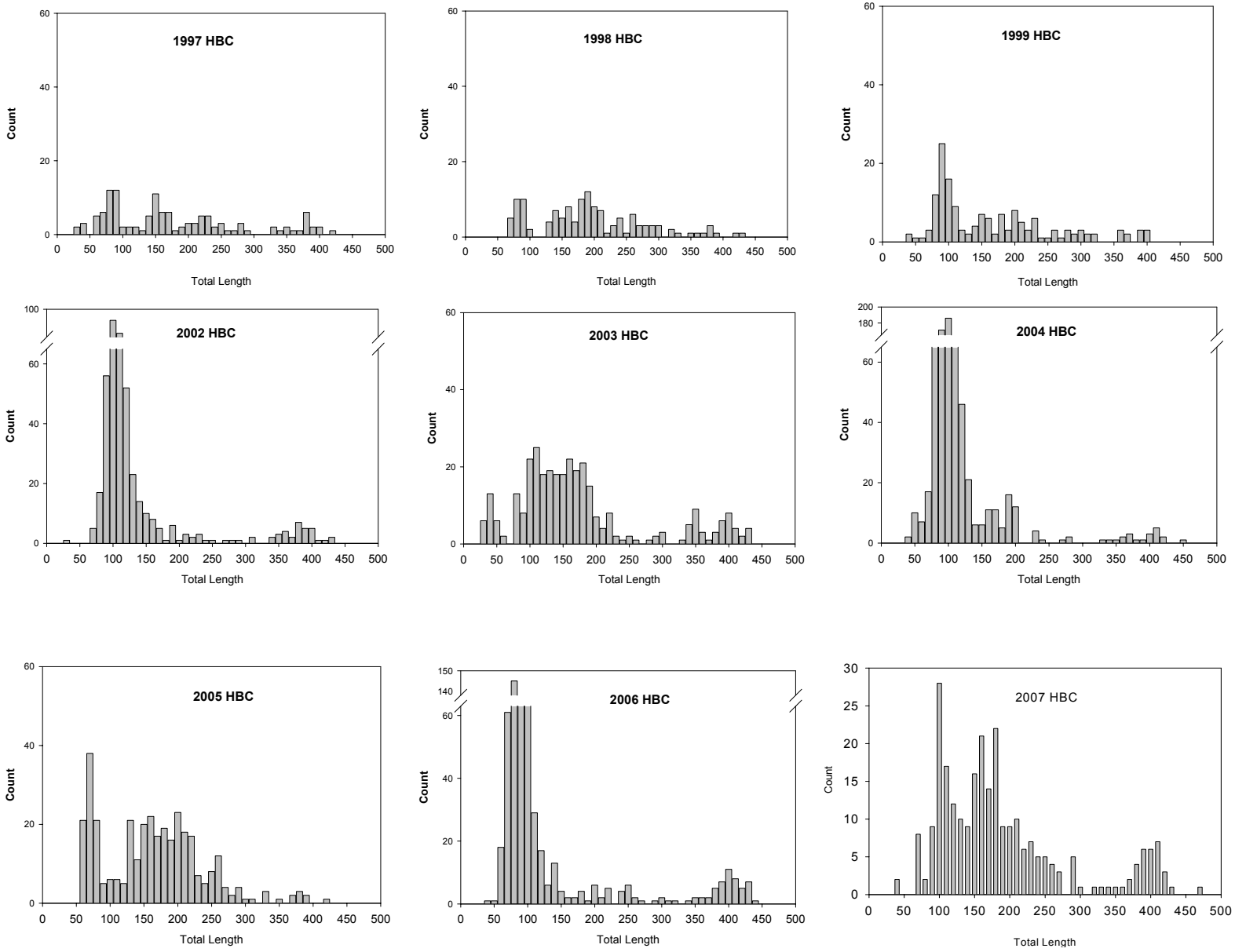

Figure 1. Length frequency distributions for humpback chub (HBC), caught in the Little Colorado River, 1997-2007. Note the difference in the y-axis scale among all histograms.

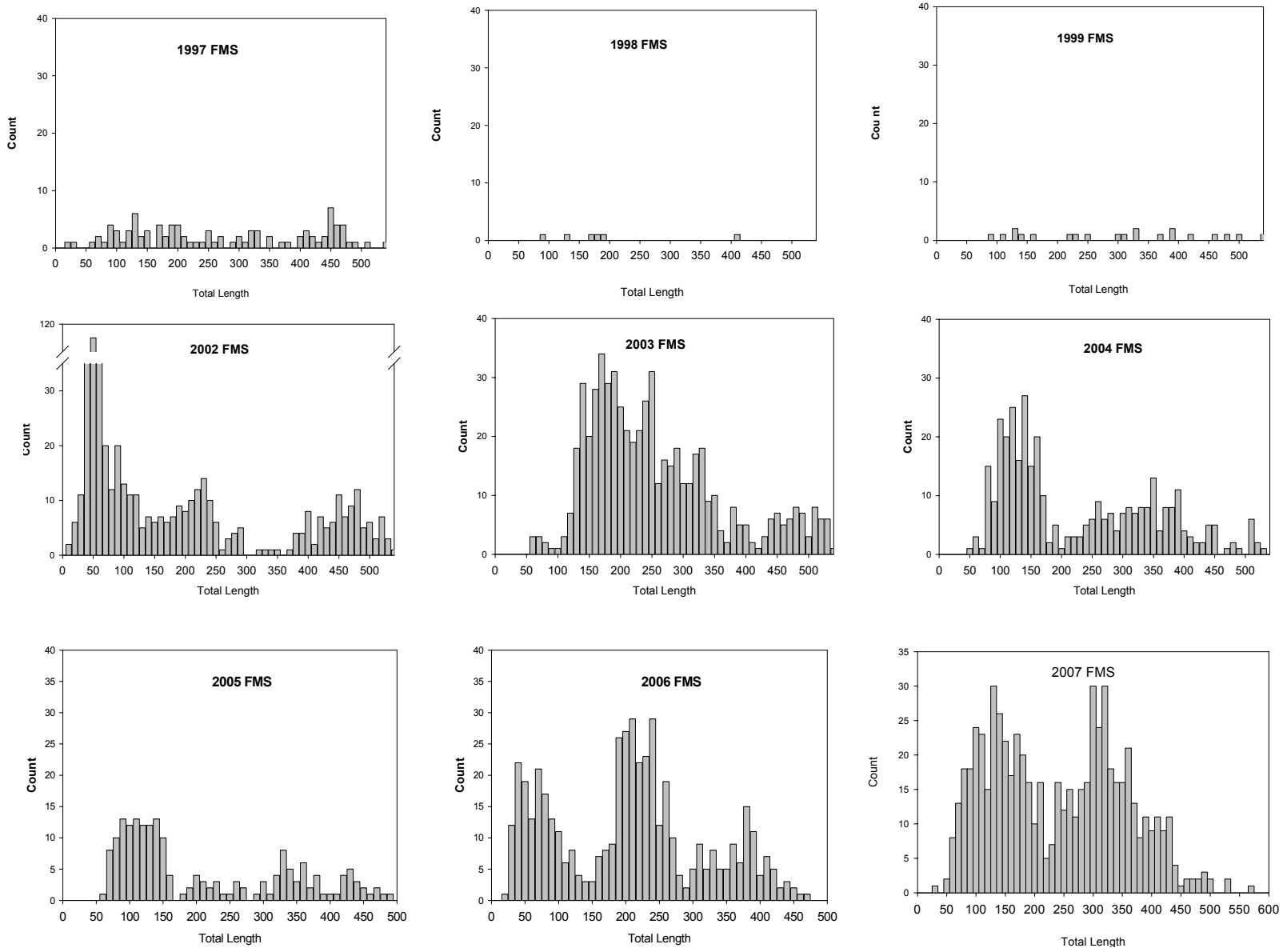

Figure 2. Length frequency distributions of flannelmouth sucker (FMS), caught in the Little Colorado River during 1997-2007. Note the difference in the y-axis scale among histograms.

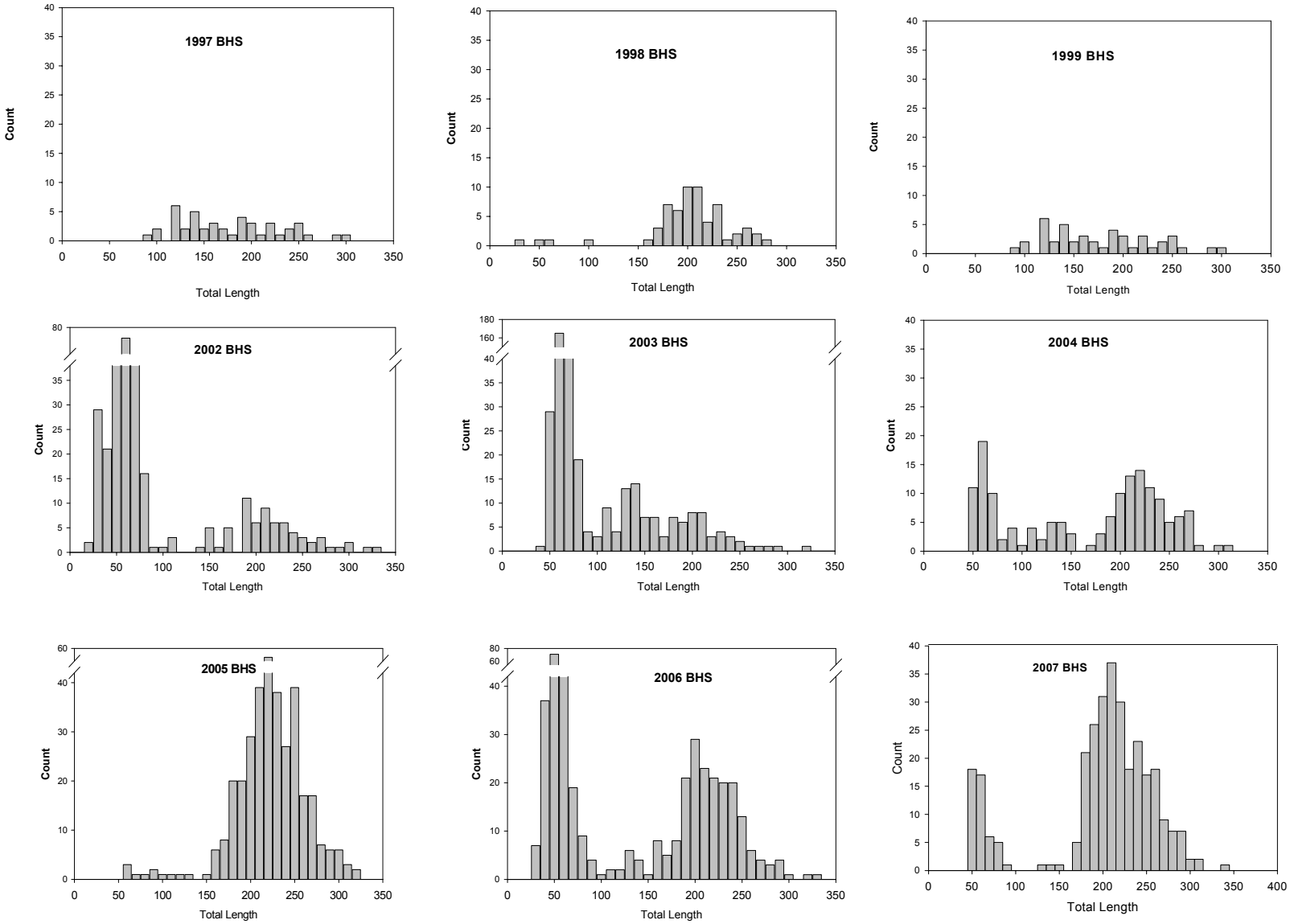

Figure 3. Length frequency distributions of bluehead sucker (BHS), caught in the Little Colorado River during 1997-2007. Note the difference in y-axis scale among histograms.

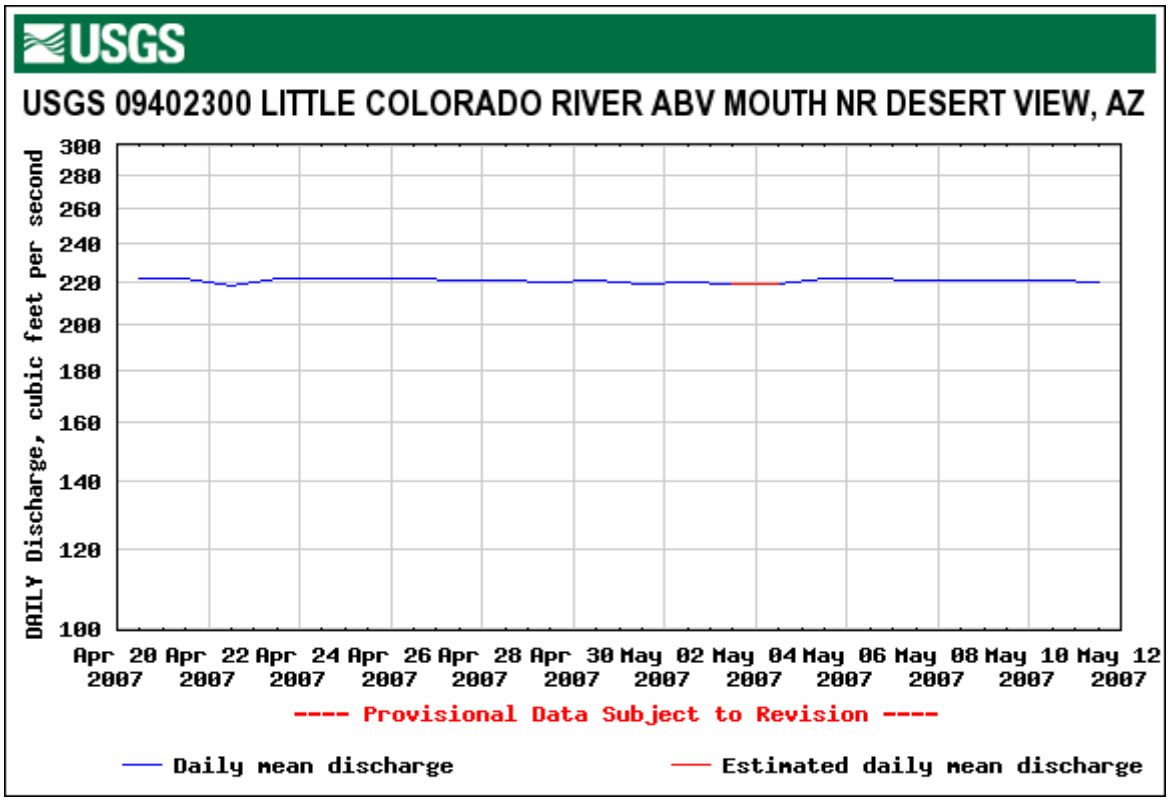

Figure 4. Mean daily flow of the Little Colorado River during the sampling period in 2007. Gauge is located above confluence with the Colorado River. Courtesy of USGS.

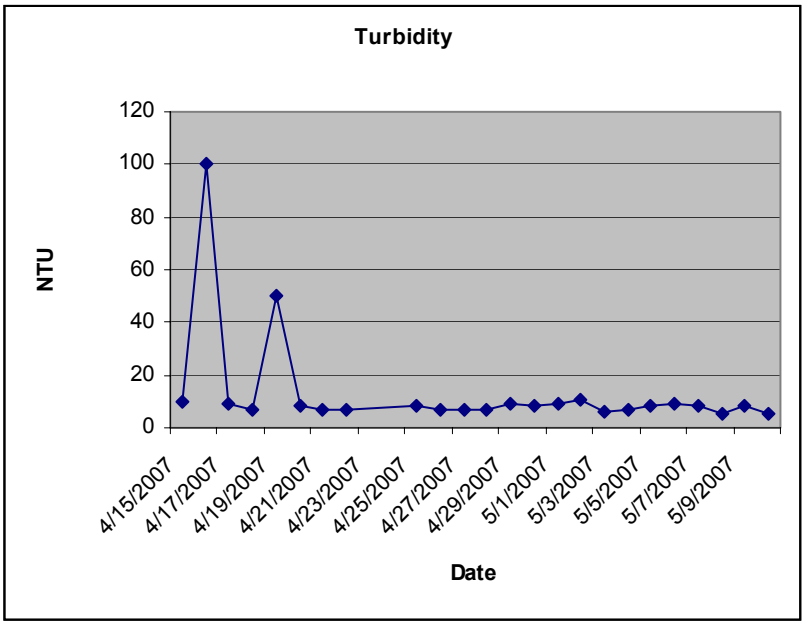

Figure 5. Mean daily turbidity (NTU's) in the Little Colorado River during 2007 sampling, Turbidity measured at Boulders Camp using a Hach 2100P Turbidimeter.

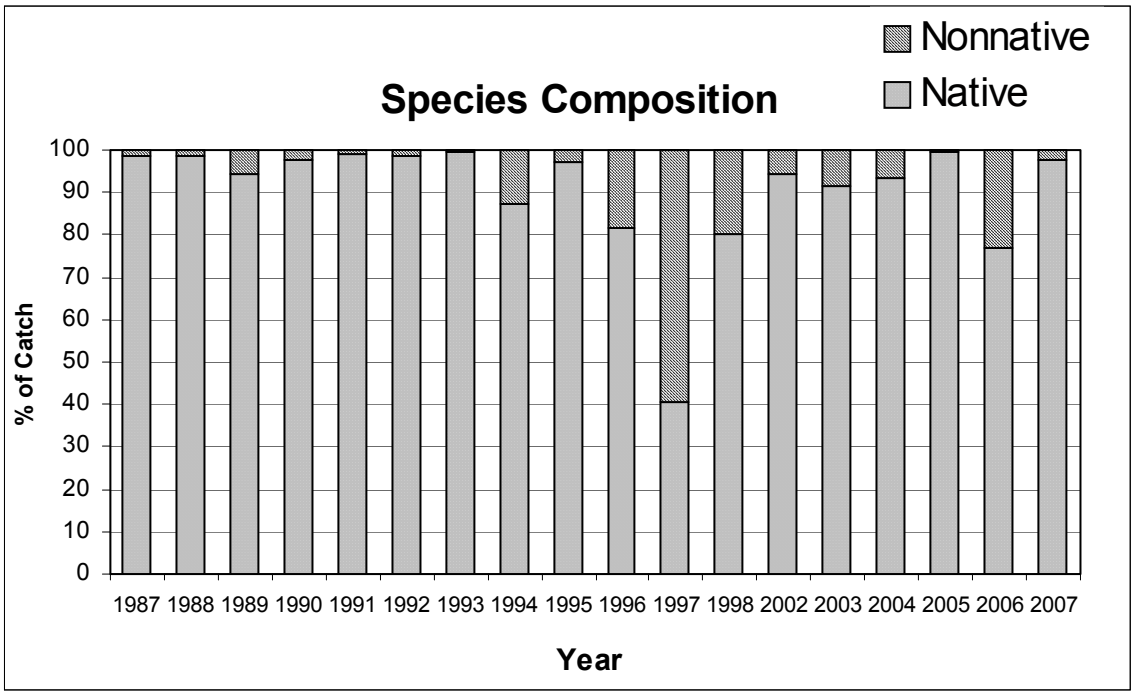

Figure 6. Species composition of fish caught in standardized hoop net monitoring, 1987 - 2007.

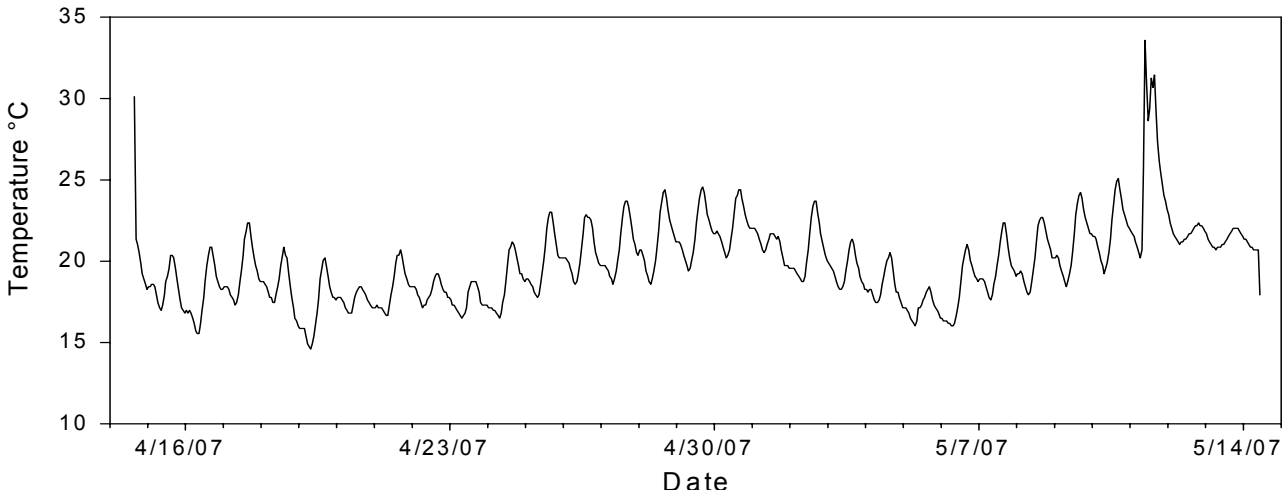

Figure 7. Daily water temperature fluctuations in the Little Colorado River during 2007 sampling (4/15-5/7), as measured with an hourly Hobotemp® data logger.

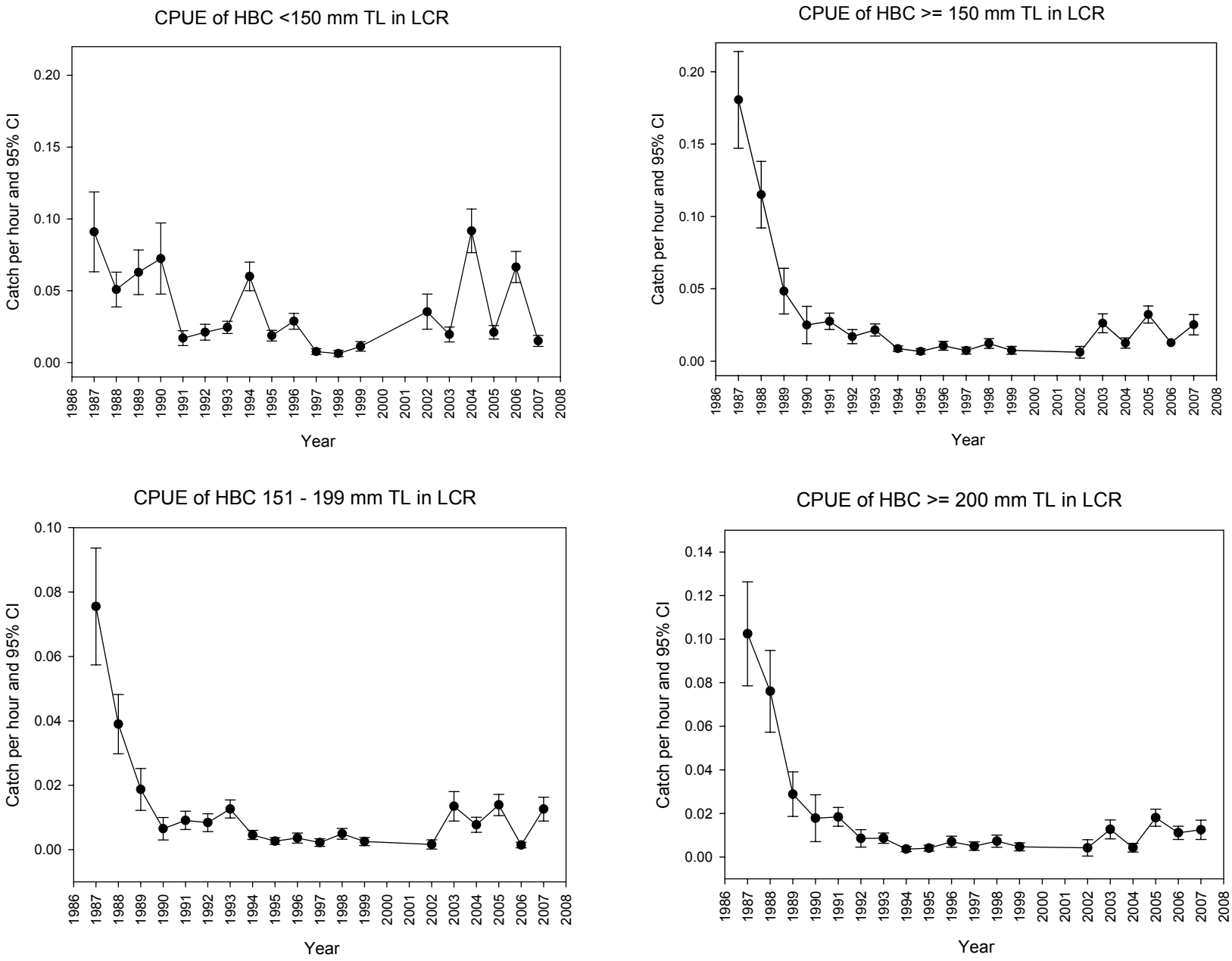

Figure 8. Mean catch/hr for 4 size groupings of humpback chub in the LCR, 1987 – 2007. Bars represent 95% confidence intervals of the mean.

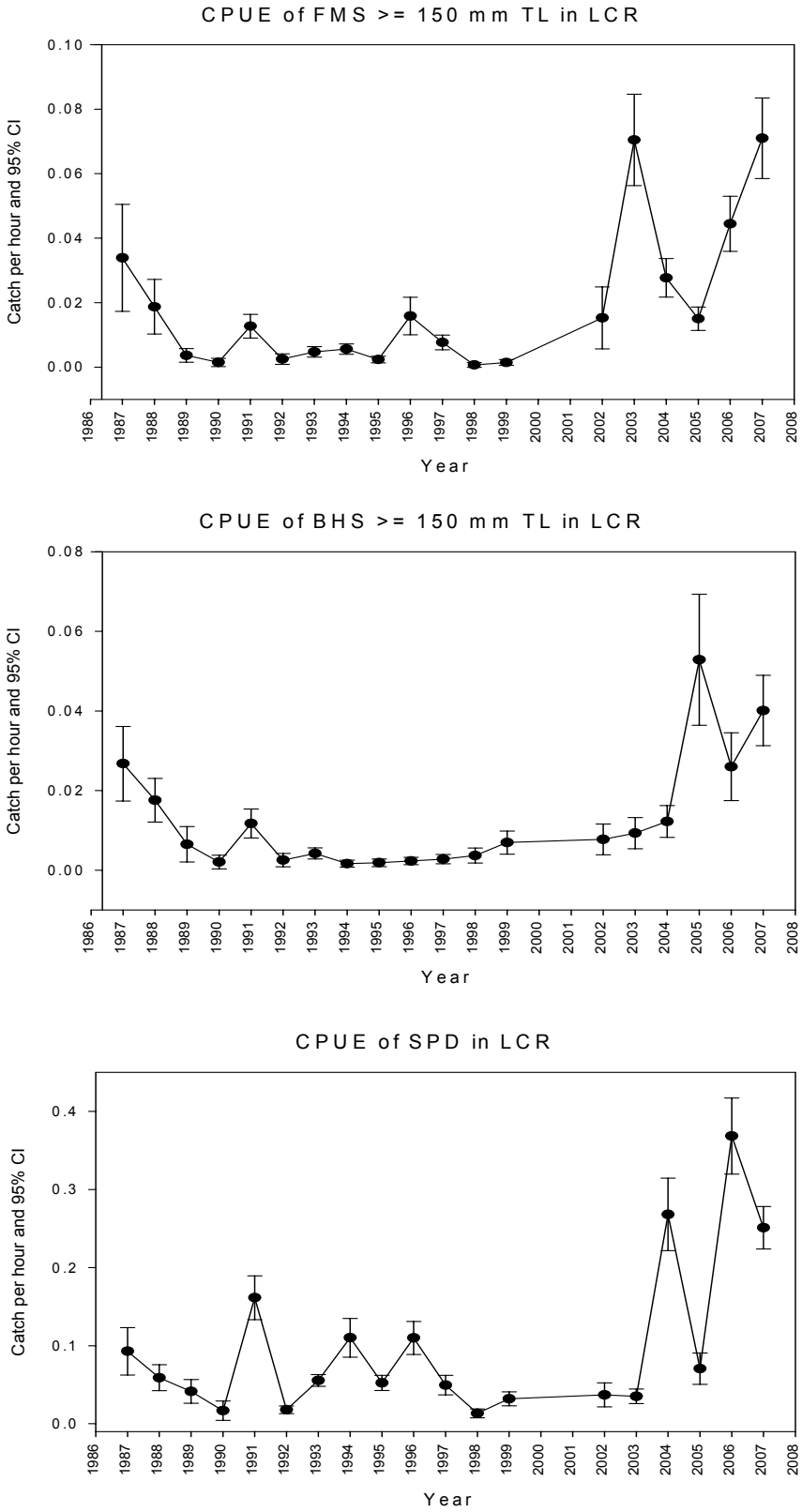

Figure 9. Mean catch/hr of flannelmouth sucker $\geq$ 150 mm TL, Bluehead sucker $\geq$ 150 mm TL and all sizes of speckled dace in the LCR, 1987 – 2007. Bars represent 95% confidence intervals of the mean.

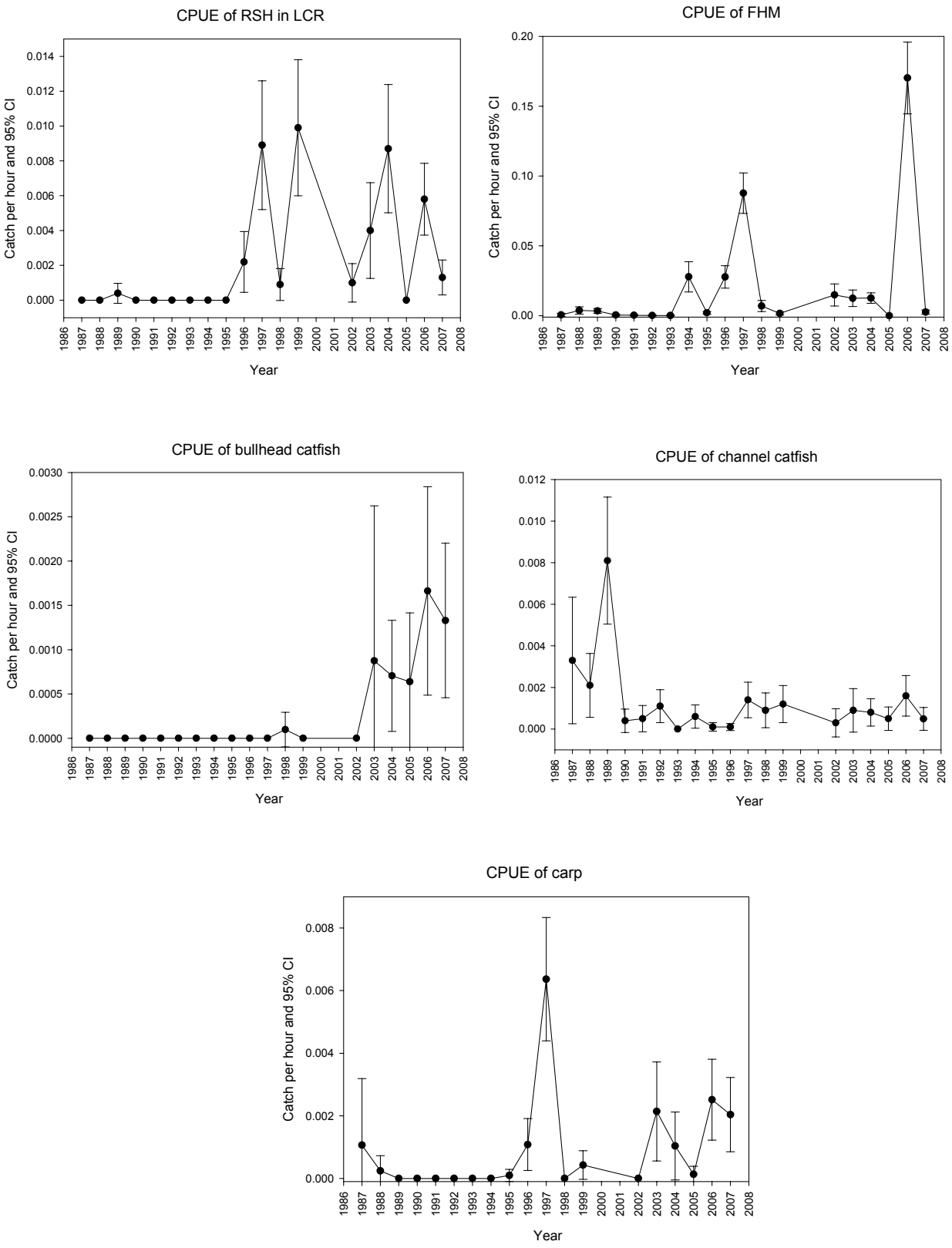

Figure 10. Mean catch/hr of nonnative fishes in the LCR, 1987-2007. Bars represent 95% confidence intervals of the mean.

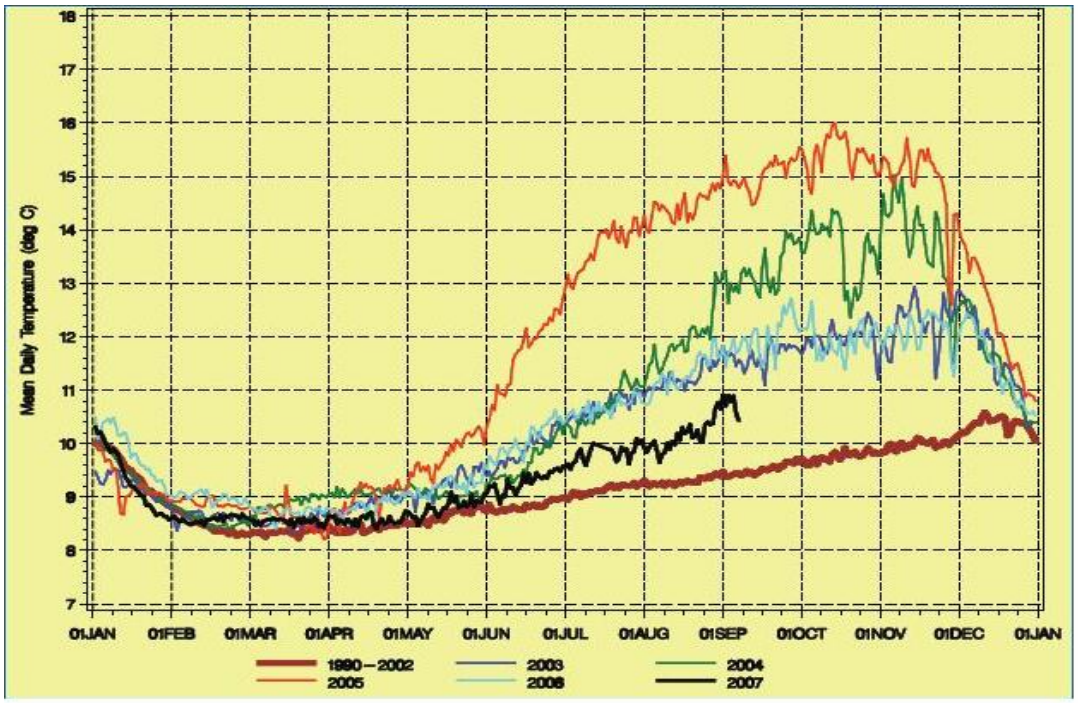

Figure 11. Mainstem Colorado River water temperature below Glen Canyon Dam. Lower line represents 1990 – 2002 water temperatures (USGS graph by Bill Vernieu).

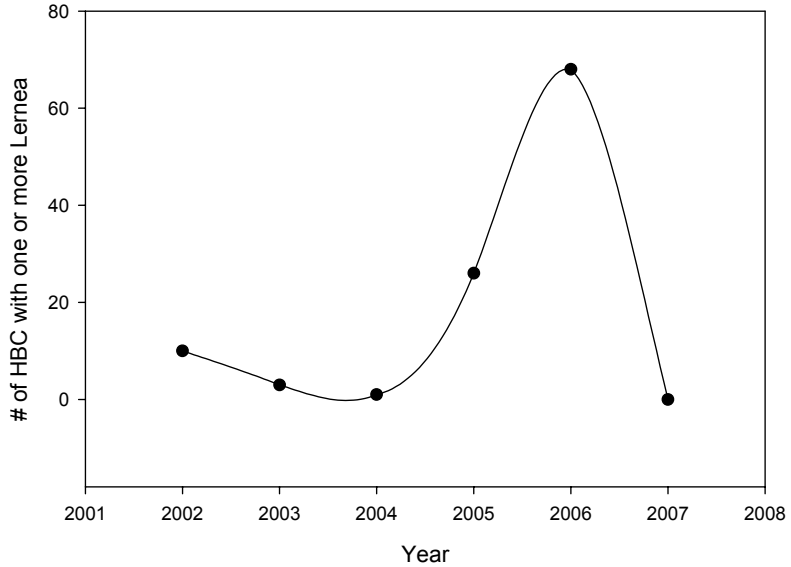

Figure 12. Incidence of *Lernea* in humpback chub from the Little Colorado River, 2002 -2007.

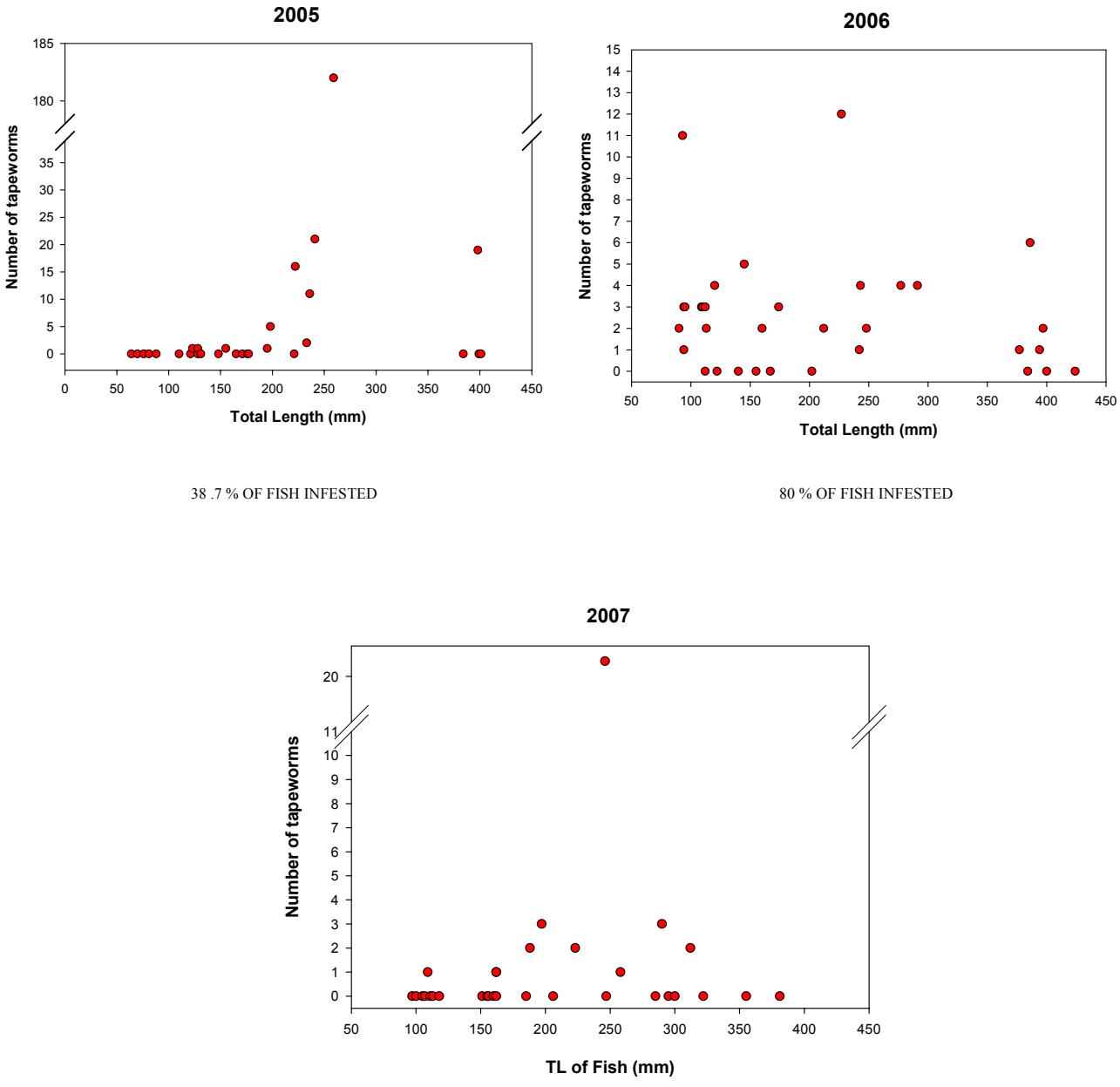

Figure 13. Asian tapeworm removed from Humpback chub in the Little Colorado River in May of 2005 -2007 using Praziquantel bath treatments.